BOEING

4th Integrated CNS Technologies Conference & Workshop

Global Communications, Navigation, and Surveillance Systems Program Progress and Plans

April 27, 2004

Chip Meserole

Boeing Phantom Works

Air Traffic Management

Global Communication, Navigation & Surveillance System (GCNSS) Program for ATM

- **FAA contract to Boeing**
  - **Contract award for $23M plus significant share by Boeing**
  - **July 2002 through May 2004**

- **GCNSS program objectives are to determine the feasibility of—**
  - **Global satellite-enhanced CNS architecture**
  - **Secure, integrated Common Information Network (CIN) architecture (now System Wide Information Management—SWIM)**
  - **Broadband, secure communications architecture**

- **Elements of approach**
  - **Systems engineering & system architecture**
  - **Tools, models & scenarios**
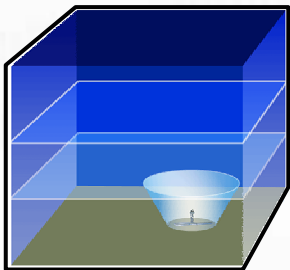 - **Demonstrations & simulations**

Transformation Vision
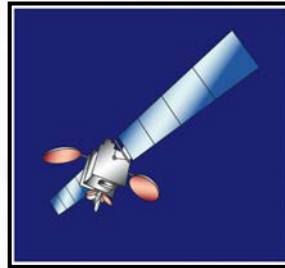
**Capacity,
with safety & efficiency** ⟸

**Precision flight
anywhere**

**4-D trajectory-based
management**

Satellite-enhanced CNS
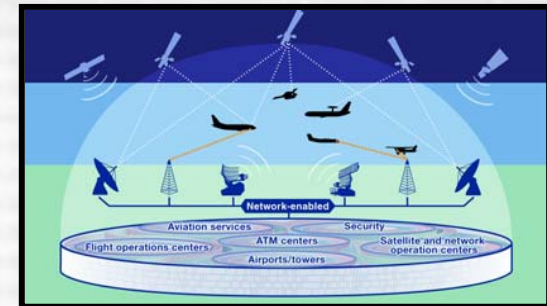
Benefits
- Cost savings globally
- Economic stimulus
- Threat deterrence
- Accident reduction
- Global interoperability

Simplified airspace design

SWIM

Network-enabled ATM

Integrated systems
- Operations
- Evolution
- Growth

**Flexibility,
with security & economy** ⟸
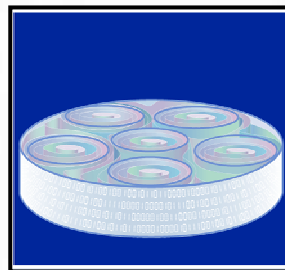
**Precision common
awareness**

Network-Enabled ATM Operations

Flight planning

Flight management

Information management system

Airspace management	Flight operations management	Flow management	Traffic management	Separation management
Up to several years	Up to 1 year	Up to 1 day	Up to 1 hour	Up to 20 minutes

Planning horizon in advance of actual time
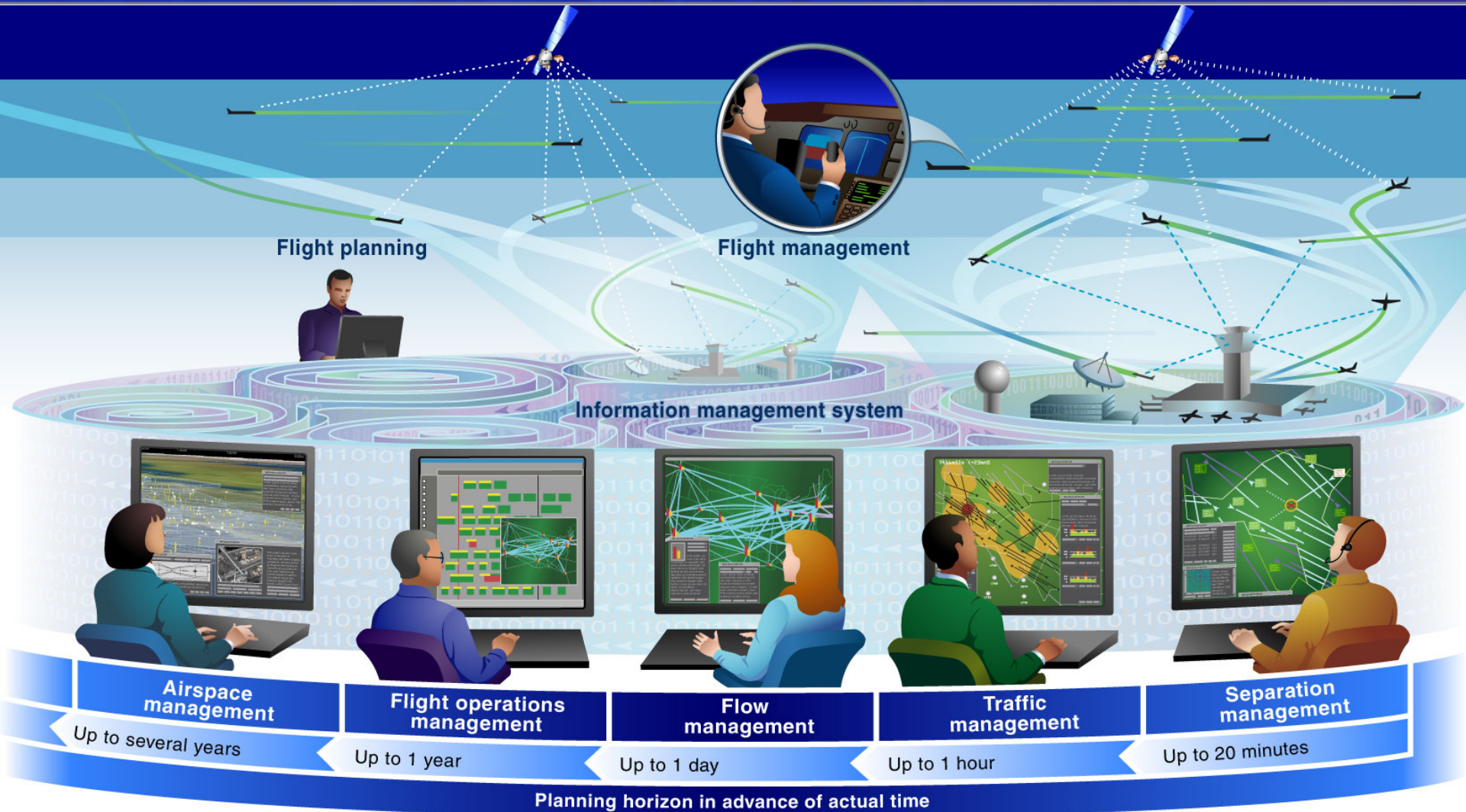
ATM Transformation

NEO transforms sum-of-systems into system-of-systems

System A

System B

System C

Information Architecture

Comm Network Architecture

ATM System Wide Information Management (SWIM)

Systems A, B, C, ...
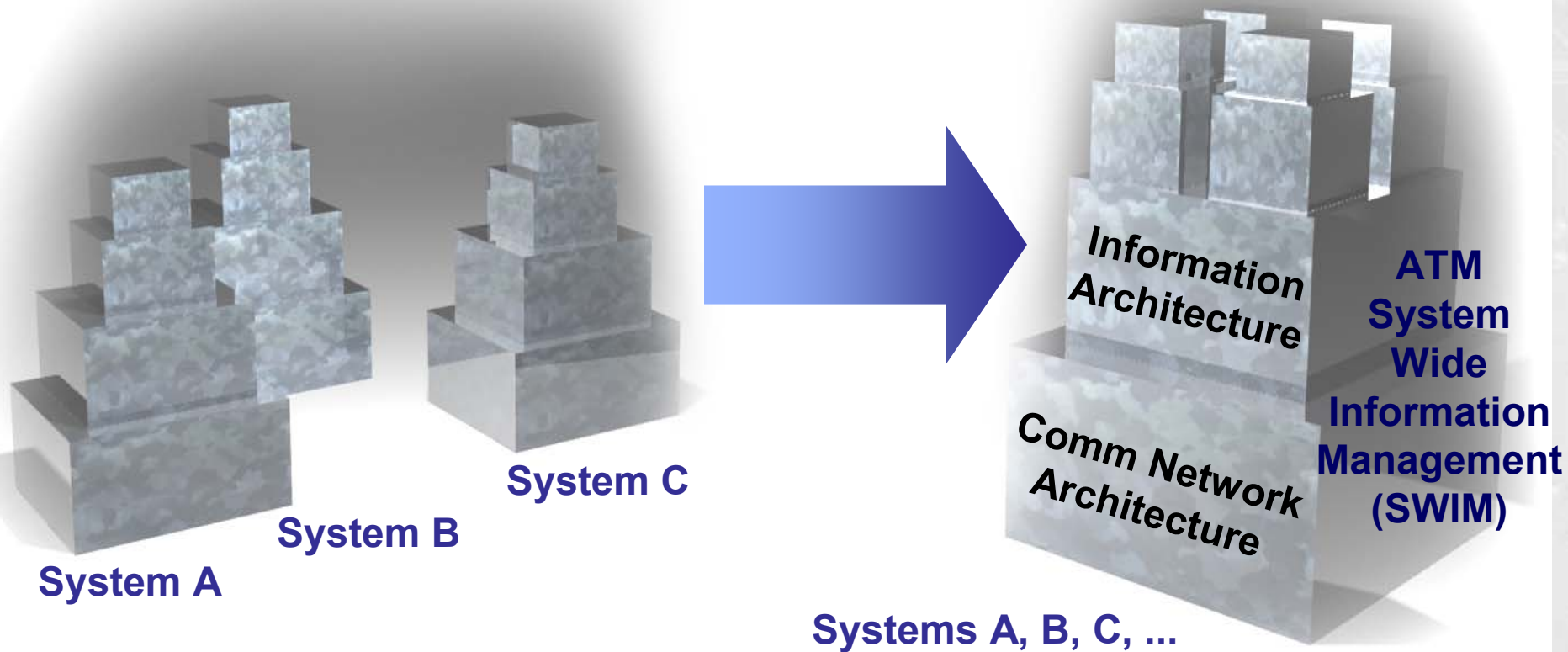
NEO and SWIM Framed in an Architecture Reference Model

Human-Interface Applications

Domain Specific Applications

| Airspace | Flow | Traffic | Separation | Security | Legacy Applications |

Support apps: Surv, AIM, Wx, Flight plans & objects...

Information Core

IP Communications Applications

Communications Core

FTI, Nexcom, Satcom, HF, etc.

Legacy Comm

NEO

CIM
Common Information Mgt

SWIM Architecture

CDT
Common Data Transport
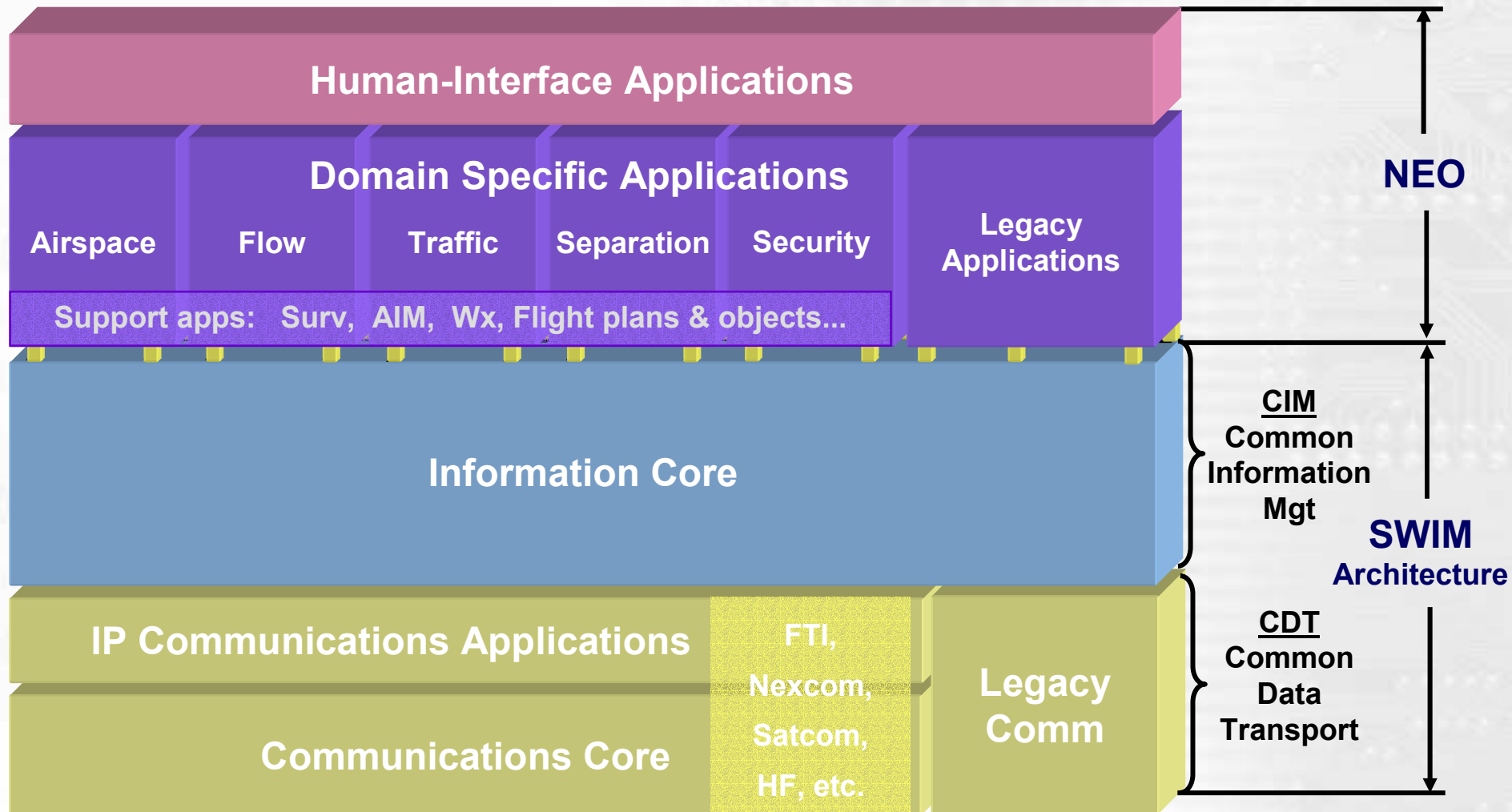
SWIM: Information and Communication

Common Data Transport System

Common Information Management System

Air-Ground Networks

Crew
Aircraft Networks
Flight Systems
Security

Military
Internet
External Networks
Government

Core Network

Radar
Services Providers
Associate Networks
ATM
Airports
Airlines
Associate Databases

Terminal
Network Operations
Satellite Operations
Support Networks

External Databases
Data Repositories

SWIM Is Integral to ATM Vision Ops Concepts

Weather Services

Dept of Defense
Homeland Security
Public Safety

Vision 2020 ATM functions are
network enabled operations

Resource allocations, Weather, NAS status, User preferences, Messages

Information
Management

Flight Objects

Airspace
Management

Flow
Management

Traffic
Management

Separation
Management

Flight
Management

AOC Flight
Planning

Flight
Plans

Flight
Plans

Flight
Plans

4D
Trajectories

4D
Trajectories

Navigation

Resource requests, Flight plans, 4D trajectories

Surveillance

Aircraft state (intent, position, velocity, acceleration, air data, aircraft status)

Model of Multiple Arrival Streams Into Chicago O'Hare
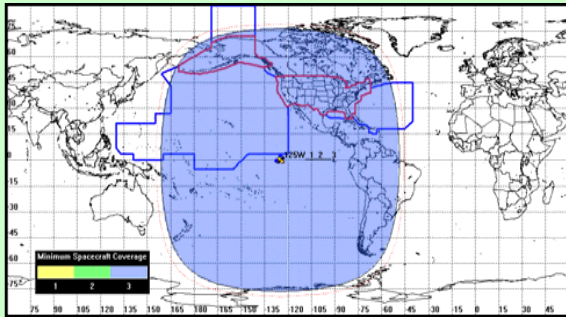**Throughput Maintained with Mixed CDA and Conventional Traffic**
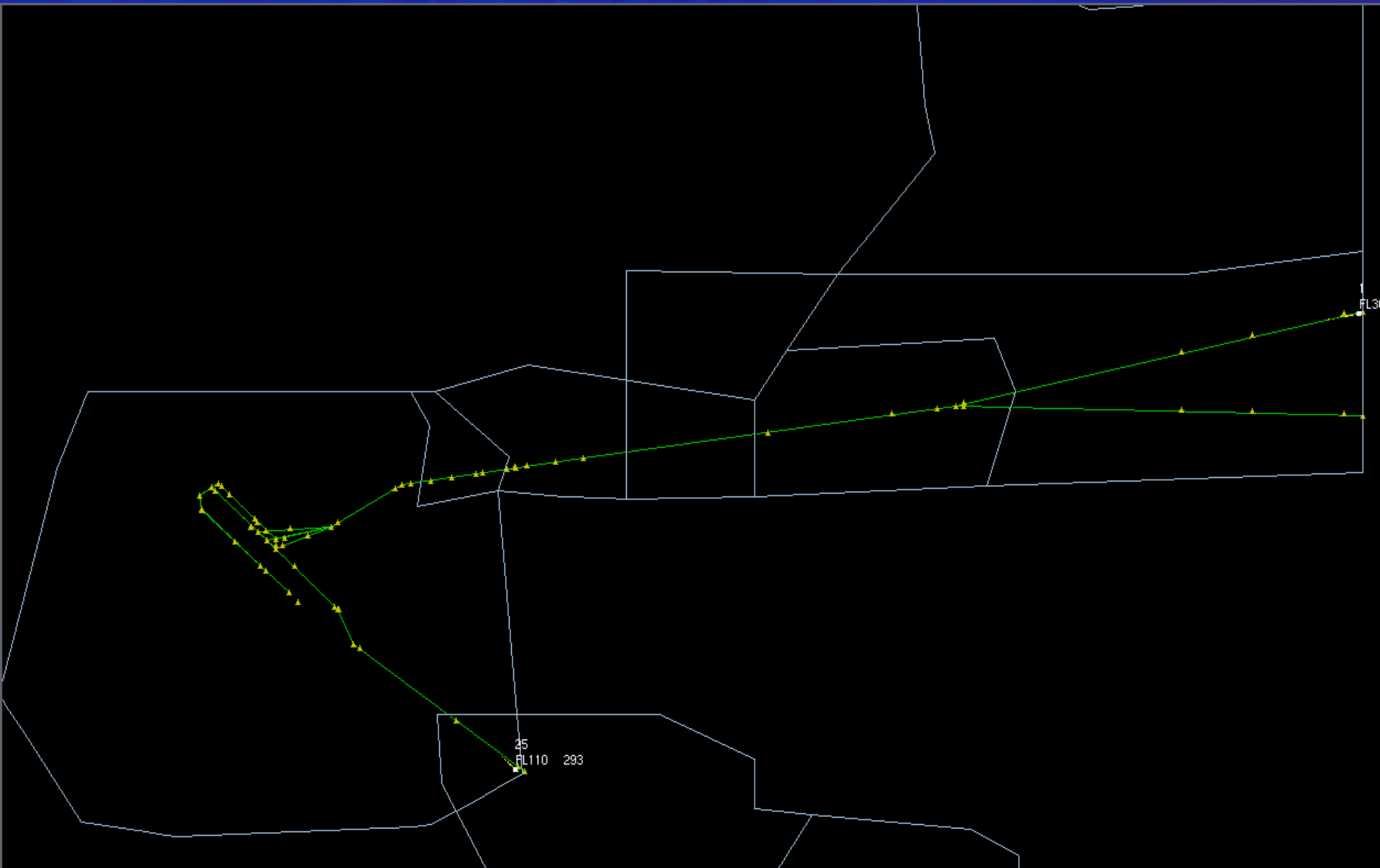
Space-based CNS Transition Options

GSO: Geostationary Orbit (circular)
iGEO: inclined Geosynchronous Orbit (circular)
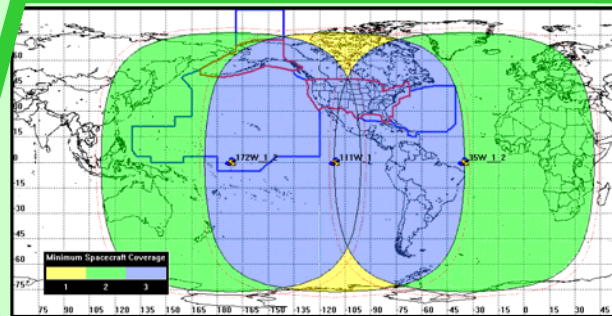ieGEO: inclined elliptical Geosynchronous Orbit (near circular)

FAA controlled airspace   **Global**

2010   **2015**

8 GSO*

5 GSO*

3 GSO*
(or equivalent)

or

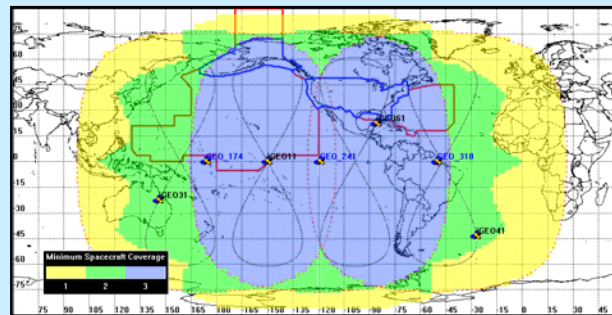**5 GSO + 5 ieGEO**

3 GSO + 4 iGEO

3 GSO + 7 iGEO

Satellite quantities will change when orbital slot and interference issues are addressed

1 or 2 ground spares needed to meet availability requirements

*GSOs cannot cover north of Alaska (~75° N latitude)

Purpose build satellites if needed for coverage, capacity, or service quality

Existing satellites   Next generation of existing satellites

Detailed Business-Case Assessments

- **SWIM for Arrival Management & Extended Terminal Management**

    - **Business case is positive**

    - **Results show compelling case for airlines to equip**

    - **SWIM can pay for itself with FAA operating cost savings**

- **Satellite Communications and Surveillance in Gulf of Mexico**

    - **Business case for North-South traffic will close if—**
        - **Continued flight growth near 8%**
        - **Satcom equipage cost is $150K or less, or is allocated to passenger services**
        - **Infrastructure costs come in at low-end**

    - **Business case for East-West traffic remains unclear (may close considering additional enabled routes)**

    - **Should extend analysis to oceanic & remote traffic**

Three GCNSS Demonstration Flight Segments

Segment A

Common Information Network (CIN) Using Broadband Communications for Flight Security

- *Demonstrated flight conformance monitoring and aircraft cabin video surveillance with on- and off-board networks*

Segment B

Global Integrated CNS Architecture Using Satellite-Based C, N, & S

- *Demonstrated satellite-based direct controller-pilot communications (voice and data) and ADS as an enabler for precision (radar-like) control in oceanic and remote domains*

Segment C

Highly Integrated CIN Using a Surveillance Data Network

- *Demonstrations in February 2004 used prototype CIN to facilitate network-enabled operations among ATC centers, aircraft, airline command centers*
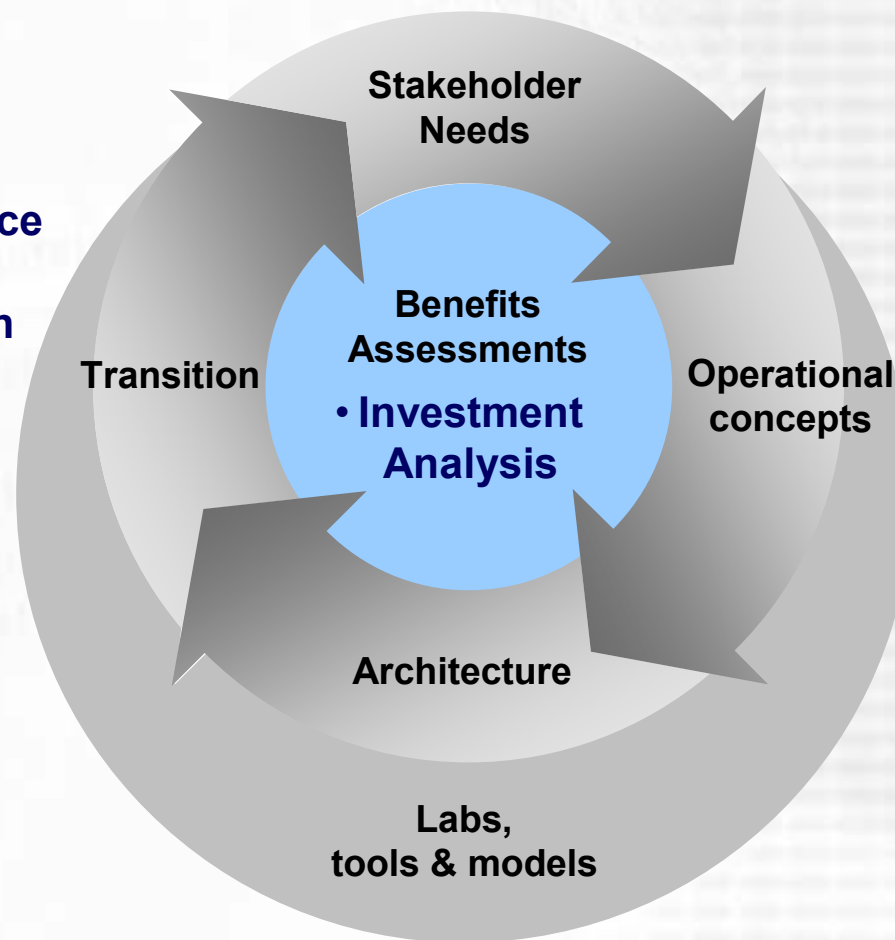
GCNSS Summary Conclusions

- **SWIM**
  - **Technology is commercially mature for ATM environment**
  - **High leverage on ATM efficiency and interagency coordination**
  - **FAA capital savings of $1.5B (~4% of F&E budget) over 25 years**
  - **Business case for airlines is positive (2:1) and will increase**

- **Satellite-based CNS**
  - **Technically feasible for NAS communications and surveillance**
  - **Commercial satcom can meet availability and coverage requirements**
  - **Extends SWIM to oceanic and remote domains**

- **Broadband satcom**
  - **Provides video and aircraft data for security and emergencies**
  - **On equipped aircraft, could be usable for ATM**

GCNSS Follow-On Objectives and Systems Engineering Flow

From GCNSS Phase I

Stakeholder Needs

Operational concepts

Architecture

Labs, tools & models

Transition

Benefits Assessments
• Investment Analysis

• **Common air surveillance picture—Demo at the National Capital Region Coordination Center**

• **SWIM prototype**
  • **Surveillance**
  • **Aeronautical info**
  • **Weather**

• **SWIM-enabled 4-D trajectory operations**

• **SWIM architecture**

• **Mobile comm & network needs**

• **Surveillance Data Network application of SWIM in laboratory**
• **Simulation based acquisition (option)**